Hydraulic testing of Model Boiler.

There seems to be some element of mystery surrounding the subject of hydraulic testing of model boilers when in fact the task is quite straightforward.

The hydraulic testing of model steam boilers is not ROCKET SCIENCE but it does require that some relatively simple equipment is made available in order to perform the task. (see attached GA diagram)

All that is required is a small, hand operated, water pump…. This can be of the simple piston type (as used for boiler water feed in a model steam locomotive), and need not be any larger than say one having a ¼” dia ram or perhaps 3/8” dia ram. This should be suitably mounted within a water container/reservoir with sufficient water to cover the ram section of the pump.

A non-return valve or alternatively a shut off valve (stop valve) should be fitted to the outlet (delivery side) of the pump in order to isolate the pump whilst the boiler under test is at pressure……. This will put less stain on the clack valve mechanism of the pump and will also eliminate the tendency for reverse leakage from the boiler under pressure. (hand pump clack valves do not seal very well in most cases)

A small manifold, consisting of nothing more than a block of metal having 4 connections on it (all interconnected) should be introduced following the non-return valve…. This will carry: -
1/ The inlet from the pump
2/. The pressure gauge.
3/ The outlet to the boiler under test.
4/ A pressure release/drain valve, with a return pipe back to the water reservoir.

The inlet connection from the pump/non-return valve can be made using standard copper pipework and soldered fittings. Typically these would be 3/16” or ¼” dia copper pipe with suitable nuts and olives.

PRESSURE GAUGE.
This should be of at least 2” dia….. 4” dia would be better. (large gauges are generally more accurate)
Ideally, it should be a properly calibrated (certified) type to ensure the readings are true (as would be the required case for boiler manufacturing, and/or boiler inspection/certification) but for home use, a good quality gauge will be sufficient.

A small model type gauge is NOT SUITABLE for this purpose.

The pressure range of the gauge should be at least 4 times maximum working pressure of the boiler under test….. this will enable the readings to be taken at around MID-SCALE…which is generally accepted as being the most accurate section on the majority of gauges.

The connection thread for such gauges are generally either 1/8” BSP or ¼” BSP so the manifold must have this port threaded accordingly.
PRESSURE RELEASE/DRAIN VALVE
This is required in order to release the pressure at the end of the test period and need be no more than a suitable IN-LINE stop valve. Ideally this valve would be of the needle valve type, since these can release the pressure more gradually, which is the more accepted way of releasing high pressure in order to avoid rapid stress changes on pressurised components.

BOILER OUTLET CONNECTION.
The thread required for this connection will depend upon the type of pipe work used to make the final connection to your boiler. As an example…… ¼” dia nylon pneumatic hose (as used for air lines etc) can be utilised and can easily be obtained for pressures up to 20bar or more. These generally have compression fittings, or crimped fittings, with 1/8” BSP or ¼” BSP threaded unions. (e.g. WADE COUPLINGS)

A rigid pipe can also be used, but is less adaptable…… the choice is yours.

TEST PROCEDURE
Fill the water reservoir of the test rig with water, to just above the pump ram level, be sure the release valve is fully closed and then give the pump a couple of strokes to clear any air from the pipework.

Connect the test rig to the boiler (generally via one of the end, or side bushes normally used for non-return valve).
Remove the safety valve, water gauge and pressure gauge from the boiler and fit blank sealing plugs in their place.

Fill the boiler with COLD, CLEAN water right up to the top…… pick it up and gently tip it around, to displace any air bubbles that may be trapped inside cross water tubes etc…. lay it down again and then pump slowly until the water runs out of the TOPMOST boiler connection (generally this would be the one at the top of the steam dome, if fitted) and then replace the plug in that opening. Be sure that all the air is out.

Slowly pump the pressure up to around 15psi and carefully check all joints on the boiler (including the sealing plugs) for signs of leakage… if any are seen then release the pressure and take remedial action.
Also check to see if there is any distortion of the end plates etc…. not likely at this low pressure, but check anyway.

Gradually increase the test pressure in 10psi steps, stopping and checking at every step for leaks etc.

Keep increasing, in steps, until the pressure reaches TWICE (2x) normal working pressure.
If you have a stop valve fitted, instead of a non-return valve, then close it and leave the boiler at this pressure for 10minutes.
Check all joints and plates every 2 minutes for any signs of leakage and distortion etc.
NOTE…… on a brand new COPPER boiler (just built) it would be normal for some small amount of end plate displacement (doming) between any stays, since the material will be in a very soft annealed state…. However, this should not be more than say 0.005” (0.125mm) at twice-max working pressure.

Any more than this, then you will need to investigate the design and possibly add more stays at closer pitch.

Such minor distortion/doming will result in the work hardening of the material, which will prevent further distortion accruing, and should not be considered as cause for concern.

There should, however, be no noticeable distortion of the main barrel.

If all is well after 10 minutes then slowly release the pressure, using the release valve.

Then repeat the test again, but this time take the pressure up in larger (20psi steps) and make sure that no further distortions etc take place. Hold again at twice maximum working pressure, this time for 20 minutes, and again checking every 2 minutes after which slowly release the pressure, empty all the water out and re-fit all the normal fittings. (safety valve, water gauge, pressure gauge etc)

You have a good pressure vessel, ready for the STEAM TEST.

Subsequent hydraulic tests (required every 4 years in the UK for boiler with total capacity of more than 3bar litres, this may be different in other countries) need only be taken to 1.5 times normal working pressure, held for 20 minutes, and only a single pass/test need be done.

NOTE WELL….. The Bar/litre capacity is the total internal capacity of the pressure vessel (excluding all air) multiplied by the Max. Working pressure in BAR. This is not the same as the normal water content of the boiler under operating conditions.

So that is all there is to it.